Pete King Wildlife Habitat Restoration Project

Water Resources Specialist Report

Prepared by:
Chris Robinson

Prepared for:
Lochsa - Powell Ranger District
Nez Perce-Clearwater National Forests
May 22, 2020

Table of Contents

Introduction

This report provides an analysis of how the proposed activities would affect water resources. The analysis focuses on those issues that have the potential to significantly affect water resources. Other issues are dismissed with a brief explanation of why. Issues were identified through a combination of internal and external scoping.

This report also demonstrates how the project is consistent with all water resources-related management direction in the Forest Plan as well as other applicable laws, rules, and regulations.

Description of the Proposed Action

The proposed action for the Pete King Restoration Project was developed and sent to the public for scoping in September 2019. Since then, we have modified some of the details of the proposal to address public comments. The Environmental Assessment describes the project objectives and corresponding resource needs and descriptions of stand treatments and road management activities.[1]

Required Design Features and Mitigation Measures

The Design Features[2] and Mitigation Measures[3] required to ensure compliance with the regulatory framework and reduce the risk of adverse impacts to water resources are documented in the project files.

Resource Indicators and Measures

Table 1. Resource indicators and measures for assessing effects to water resources

Resource Element	**Resource Indicator**	**Measure (Quantify if possible)**
Water Quality	Sediment Delivery	Amount of sediment delivery to project streams (tons per year)
Watershed Function	Peak Stream Flows	Change in Peak Stream Flows (percent)

Resources Not Analyzed in Detail

Proposed activities would not affect floodplains, wetlands, municipal watersheds, stream temperature, or road density because of the lack of an adequate cause-effect relationship. Riparian Habitat Conservation Areas would maintain floodplains, wetlands, and streams. No timber harvest or road building would occur adjacent to streams. Project activities occurring in municipal watersheds would be limited to log haul and a small amount of road maintenance on existing drivable roads.[4] Design Features and Best Management Practices (Appendix A) would be used to minimize impacts from these activities to municipal watersheds. Road density would remain unchanged because no new permanent roads would be constructed.

Cause-Effect Relationships

Water Quality – Sediment Delivery

Sediment delivery to streams is a natural process and can result from events such as landslides and wildfires. These events can deliver tremendous amounts of sediment but occur infrequently over time. Moody and Martin (2009) reviewed post-wildfire literature and found that wildfires resulted in an average of 37 tons per acre of sediment delivery from hillslopes with even larger yields from stream channels. Aquatic ecosystems on the forest evolved within the context of these kinds of events.

Sediment inputs to stream channels occur as a complex series of pulses that are delivered and stored within low order, high gradient stream channels (Benda & Dunne, 1997). Sediment accumulates for centuries within these channels before being transported or "flushed" downstream by episodic events with large increases in water yield (Kirchner et al., 2001). Transport of sediment plays a fundamental role in the natural function of forested watersheds. However, too much sediment damages aquatic habitat, disrupts the connection between surface water and groundwater in streams, enhances the transport of pollutants, and increases treatment costs associated with municipal water withdrawal (Rehg, Packman, & Ren, 2005).

Forests generally have very low erosion rates unless they are disturbed (Elliot, Hall, & Scheele, 2000). Common disturbances include timber harvest operations, roads, prescribed burning, and wildfires (Elliot, Page-Dumroese, & Robichaud, 1999). Impacts to soil erosion from these activities last a few years before rapid revegetation covers the surface with protective plant litter (Elliot, 2004). However, not all disturbance is short-lived. Numerous studies document that forest roads are often the leading contributor of sediment to stream channels (Bilby, Sullivan, & Duncan, 1989; Duncan, Bilby, Ward, & Heffner, 1987; Gucinski, Furniss, Ziemer, & Brookes, 2001).

Forest roads can be chronic sources of sediment because road construction, use, and maintenance compact soils, reduce infiltration, intercept and concentrate surface and subsurface runoff, and limit the growth of vegetation. Road ditches can alter natural drainage patterns and move sediment directly from roads into streams (Wemple, Jones, & Grant, 1996). Also, roads can increase the frequency and magnitude of landslides by undercutting the base of unstable slopes; intercepting, diverting, and concentrating runoff to unstable hillsides; and through damage caused by plugged culverts that cause water to overtop the road. If roads are located on sensitive landtypes, they are more likely to fail. These characteristics can harm water resources. While sediment delivery from roads may be relatively minor compared to landscape-scale inputs, sediment delivery from roads can easily be reduced and should be addressed where necessary.

Watershed Function – Peak Stream Flows & Channel Form and Function

Removal of tree canopy and vegetation can affect how water moves through a watershed (Grant, Lewis, Swanson, Cissel, & McDonnell, 2008; Julia A. Jones & Post, 2004) and the stability of stream channels downstream (Olsen, Whitaker, & Potts, 1997). Vegetation removal can either occur as a result of natural events such as wildfire and insect and disease outbreaks or human-caused activities such as timber harvest, mining, and conversion of forested lands to other land uses. Prior research has so far not revealed a direct link between timber harvest and changes to stream channel form and function.[5] Recent research suggests that any potential effects of vegetation removal from timber harvest is typically limited to low-gradient reaches, and the likelihood of stream channels being affected by small changes to the size of peak stream flows is very low (Safeeq, Grant, Lewis, & Hayes, 2020). However, in response to public comments, this report will analyze potential effects from proposed activities to stream channels.

Data Sources

Table 2. Data sources for the analysis of project effects to water resources

Data Type	Source Name	Updated[6]	Description	Analyses Used In
Aerial Imagery	National Agriculture Imagery Program (NAIP) Imagery	2017	NAIP acquires aerial imagery during the agricultural growing seasons in the continental U.S. A primary goal of the NAIP program is to make digital ortho photography available to governmental agencies and the public within a year of acquisition. NAIP imagery is acquired at a 1-meter ground sample distance with a horizontal accuracy that matches within six meters of photo-identifiable ground control points, which are used during image inspection. The default spectral resolution is natural color (Red, Green and Blue, or RGB).	Effects to floodplains, wetlands, peak stream flows and channel morphology
Area Geology	Geologic Map of Idaho	2012	Maps out the underlying geology of the State of Idaho at a scale of 1:750,000.[7]	Effects to road-related sediment
Bare Earth Hillshade	Project Specific LiDAR (LIght Detection And Ranging) – WaldePlacerPete_King_DerivativeGDB	2010	LiDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. These light pulses – combined with other data recorded by the airborne system – generate precise, three-dimensional information about the shape of the Earth and its surface characteristics. A LiDAR instrument principally consists of a laser, a scanner, and a specialized GPS receiver. Airplanes and helicopters are the most commonly used platforms for acquiring LiDAR data over broad areas. Topographic LiDAR typically uses a near-infrared laser to map the land. This LiDAR-derived bare earth hillshade has a resolution of 1m.	All
Elevation Data	Project Specific LiDAR – WaldePlacerPete_King_DerivativeGDB	2010	This LiDAR-derived bare earth elevation model has a resolution of 1m.	Effects to peak stream flows and channel morphology, road-related sediment
Elevation Data	US Forest Service Region 1 LiDAR Data	2009	This LiDAR-derived bare earth elevation model has a resolution of 30m.	Effects to hillslope sediment delivery, peak stream flows and channel morphology, road-related sediment
Forest Service Management Activities	Forest Service Activity Tracking System (FACTS)	Ongoing; retrieved on 10/10/2019	The FACTS database tracks the status of proposed forest management activities on National Forest System lands, including timber harvest, prescribed fire, and restoration activities.	Effects to hillslope sediment delivery, peak stream flows and channel morphology, road-related sediment
GRAIP_Lite Calibration Datasets	Basalt – Payette NF; Belt Super Group – Lolo, Helena, Flathead NFs; Granite, Boise NF	2010-2014	Calibration datasets contain data on erosion baserates, vegetation factors, and stream connection probability for their respective dominant ecoregions. This information was derived from extensive field work that identified stream connection, road surface type, recent road maintenance, and flowpath vegetation for each road segment and recorded this information in a database.	Effects to road-related sediment

Data Type	Source Name	Updated[6]	Description	Analyses Used In
HUC 12 Watershed Boundaries	Watershed Boundary Dataset	Ongoing; retrieved on 4/9/19	The intent of defining Hydrologic Units within the Watershed Boundary Dataset is to establish a base-line drainage boundary framework, accounting for all land and surface areas. Hydrologic units are intended to be used as a tool for water-resource management and planning activities particularly for site-specific and localized studies requiring a level of detail provided by large-scale map information. The Watershed Boundary Dataset is a comprehensive aggregated collection of hydrologic unit data consistent with the national criteria for delineation and resolution. It defines the areal extent of surface water drainage to a point except in coastal or lake front areas where there could be multiple outlets as stated by the "Federal Standards and Procedures for the National Watershed Boundary Dataset" "Standard" (http://pubs.usgs.gov/tm/11/a3/). Watershed boundaries are determined solely upon science-based hydrologic principles, not favoring any administrative boundaries or special projects, nor particular program or agency. This dataset represents the hydrologic unit boundaries to the 12-digit (6th level) for the entire United States. At a minimum, they are delineated at 1:24,000-scale in the conterminous United States.	Effects to peak stream flows and channel morphology
Road Data	US Forest Service Infrastructure Database (Infra)	Ongoing; retrieved 10/10/19	Infra stores road-related data such as jurisdiction, road surface type, and road maintenance level for all US Forest Service system roads.	Effects to peak flows and channel morphology, road-related sediment
Soil Types	Web Soil Survey	2018 (Clearwater National Forest, Idaho Soil Survey, Version 8; Kooskia Area, Idaho County, Idaho, Version 13); retrieved 7/2/19	Web Soil Survey provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties. The site is updated and maintained online as the single authoritative source of soil survey information.	Effects to hillslope sediment delivery, road-related sediment
Source Water Protection Areas	Forest Service S_R01.WaterSourceDelineationsIdaho	Unknown; retrieved 10/10/19	These datasets are part of the Idaho Department of Environmental Quality's Source Water Protection program. Delineations, also known as capture zones, were created as part of the State of Idaho Source Water Protection program. The delineations can be classified as one of two categories: fixed radius and modeled. Transient and surface water systems were delineated with the fixed radius method. The remaining systems were delineated utilizing groundwater modeling.	Effects to municipal watersheds

Data Type	Source Name	Updated[6]	Description	Analyses Used In
Vegetation Type Mapping	Region 1 Vegetation Mapping Program (R1 VMap)	2011	VMap is a multi-level, existing vegetation geospatial database used to produce four primary map products; lifeform, tree canopy cover class, tree diameter, and tree dominance type. The VMap database can produce products to meet information needs at various levels of analysis according to National and Regional direction established by the Existing Vegetation Classification and Mapping Technical Guide and the Region 1 Multi-level Classification, Mapping, Inventory, and Analysis System. This feature class (VMap_Base) is to be used at base-levels (e.g., landscapes, projects) of analysis and contains features at least 1 acre in size. The details of vegetation classification, base-level database development, and VMap accuracy assessment are included in a variety of documents posted on the VMap web site (http://www.fs.fed.us/r1/gis/VMapWebPage.htm). This product was created by using an iterative and interactive process. Existing vegetation was described at multiple levels of spatial and thematic resolution. As a first step in the vegetation classification process, each stand polygon of the landscape was described by a suite of spectral and biophysical attributes. In total, the mean value of each of thirty-seven different layers of information was summarized for each polygon. The information was derived from various levels of remotely sensed imagery, and topographically derived grid-based data layers. To provide a consistent processing environment, all data layers were formatted to 10-meter pixel dimensions. The spectral information used in this project is based on imagery collected in 2011.	Effects to peak stream flows and channel morphology
Wetland Type and Extent	National Wetlands Inventory Wetlands Mapper	2018; retrieved 4/4/19	The Wetlands Mapper is designed to promote greater awareness of wetlands geospatial data applications and to deliver easy-to-use, map like views of America's wetland resources in a digital format. It has been developed in collaboration between the U.S. Fish and Wildlife Service and the U.S. Geological Survey. The Service's topical wetland and riparian maps are graphic representations of the type, size and location of the wetlands, deepwater or riparian habitats in the U.S. These maps have been prepared from the analysis of high-altitude imagery in conjunction with collateral data sources and field work. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site, may result in revision of the wetland boundaries or classification established through image analysis. The Service uses the Cowardin et al. 2nd Edition (2013) definition of wetland. This definition is the National Standard for wetland mapping, monitoring, and data reporting as determined by the Federal Geographic Data Committee in 2013.	Effects to floodplains, wetlands
Wildfire Occurrence	Fire Occurrence point layer Fire Perimeter point layer	Ongoing; retrieved on 10/18/19	The FireOccurrence point layer represents ignition points from which individual wildland fires started. Data are maintained at the Forest/District level, or their equivalent, to track the occurrence and the origin of individual wildland fires. Records in FireOccurrence include historical fire point records from a variety of sources. Since 1986, FIRESTAT, the Fire Statistics System computer application, has been the authoritative data source for all wildland fire occurrences on National Forest System Lands. FIRESTAT is used by the USFS to enter and maintain information from the Individual Wildland Fire Report. The Individual Wildland Fire Report is the record of fire occurrence required of all Forest Service units. FireOccurrence records include information entered into FIRESTAT, in addition to fire occurrences which pre-date the use of FIRESTAT. For additional technical information, see: http://fsweb.datamgt.fs.fed.us/documents/current_data_dictionary/fire/FireOccurrenceGISDD_TechnicalAddendum.doc.	Effects to hillslope sediment delivery, peak stream flows and channel morphology

Analytical Assumptions

All Water Resources

- All analysis and modeling are based upon the best available data. I have done my best to disclose any data gaps or unknown information. If new information should become available, it would be stated and incorporated into the analysis.
- PACFISH Riparian Habitat Conservation Areas (stream-side areas managed specifically to maintain and improve water quality and fish habitat) would exclude timber harvest within the areas described in the Design Features. If additional water features or landslide-prone areas are found in the field during layout and implementation, the appropriate Riparian Habitat Conservation Area width would be applied.
- Average clearing limits are 16 feet for new temporary roads (Reeves, 2011). The actual road prism dimensions would depend on site-specific conditions and would vary road-by-road.

Water Quality – Sediment Delivery (Hillslopes)

- I analyzed treatment units as being logged with the most impactful system probable given the slope, distance from roads, and unit shape. Some treatment units may use more than one type of logging system but would be analyzed for the most impactful. This overestimates ground disturbance and effects to water resources.
- The average slope of ground-based harvest units is 33 percent (derived from 1-m LiDAR).
- The average slope of cable-based harvest units is 48 percent (derived from 1-m LiDAR).
- The average slope of helicopter-based harvest units is 55 percent (derived from 1-m LiDAR).
- The average slope of prescribed fire treatment units is 61 percent (derived from 1-m LiDAR).
- The average slope of Riparian Habitat Conservation Areas is 55 percent (derived from 1-m LiDAR).
- Average hillslope length for treatment units does not exceed 1,200 feet (that is, the maximum value for the Disturbed WEPP model). LiDAR data shows that 1,200 feet approximates the *maximum* hillslope length for treatment units. This overestimates sediment production for treatment units. I analyze hillslope length for Riparian Habitat Conservation Areas at 100 feet (that is, the narrowest width that would be implemented and the "worst-case scenario"). The effects to fish-bearing and perennial, non-fish-bearing streams would be less than what is analyzed due to their greater widths (300 and 150 feet, respectively).
- The "20 Year Old Forest" treatment/vegetation type in Disturbed WEPP with 95 percent cover most closely matches the existing condition of forested treatment units (Dun et al., 2009; Elliot, Hall, & Scheele, 2000).
- The "5 Year Old Forest" treatment per vegetation type in Disturbed WEPP with 95 percent cover most closely matches the condition of forested treatment units where ground-based harvesting and grapple piling of activity fuels occurs (Dun et al., 2009; Elliot et al., 2000).
- The "Shrubs" treatment per vegetation type in Disturbed WEPP with 80 percent cover most closely matches the condition of all treatment units managed to maintain early seral habitat (Elliot, 2013; Elliot et al., 2000).

- The "Low Severity Fire" treatment per vegetation type in Disturbed WEPP with 85 percent cover most closely matches the condition of treatment units where cable- or helicopter-based harvesting and broadcast burning of activity fuels or prescribed fire occurs (Elliot, 2013; Elliot et al., 2000).
- Design Features, Best Management Practices, and Riparian Habitat Conservation Areas would minimize sediment delivery from treatment units (Litschert & MacDonald, 2009; Rashin, Clishe, Loch, & Bell, 2006; Roper, Saunders, & Ojala, 2019; Warrington et al., 2017).
- At best, any predicted runoff or erosion value is within plus or minus 50 percent of the true value (Elliot et al., 2000).
- Erosion rates are highly variable, and most models can predict only a single value. Replicated research shows that observed values vary widely for identical plots or the same plot from year to year (Elliot, Foltz, & Luce, 1995; Tysdal, Elliot, Luce, & Black, 1999). Spatial variability and variability of soil properties add to the complexity of erosion prediction (Robichaud & Monroe, 1997). Multiple studies demonstrate the ability of WEPP to accurately estimate runoff and sediment delivery from management activities and fire (Dun et al., 2009; Elliot, 2004; Laflen, Flanagan, & Engel, 2004).
- WEPP predictions of sediment delivery reflect the influence of large storm events in WEPP simulations and results. These large events, while predicted to generate runoff volumes that could deliver sediment through a Riparian Habitat Conservation Area, are infrequent and have a low probability of occurring.
- Sediment delivery less than one half ton per acre per year is undetectable and negligible (W.J. Elliot, USFS Rocky Mountain Research Station, as cited in Traeumer, 2018).

Water Quality – Sediment Delivery (Roads)

- Non-channelized runoff from roads is not likely to travel more than 300 feet with most sediment settling out within 200 feet of where the road drains to the forest floor (Belt, O'Laugblin, & Merrill, 1992).
- When using the GRAIP_Lite sediment prediction model, using a calibration dataset from a GRAIP study in a similar geophysical setting increases the accuracy and precision of the modelled sediment yield. Although a GRAIP study has not been done in an area with the same geology, several GRAIP_Lite calibration sets are used in this analysis (see Data Sources section above) to best approximate conditions in the project area. This is adequate for using GRAIP_Lite as a tool to efficiently identify road segments that pose the greatest risk of chronic sediment delivery to streams. The accuracy of the modeling results is not adequate for use in quantifying the absolute amounts of sediment production for road segments in this analysis.
- Recontouring or obliterating temporary roads minimizes their contribution to long-term runoff, erosion, and sediment delivery (Foltz, Rhee, & Yanosek, 2007; Switalski, Bissonette, DeLuca, Luce, & Madej, 2004).
- When sediment leaves a road, the greatest impact to water quality is immediately below where it enters a stream. Effects decrease quickly within several hundred feet and return to near-background levels within one half mile even without mitigation (Foltz, Yanosek & Brown, 2008; Schmalenberg, n.p.). I assume that using Best Management Practices (see Appendix A; BMPs

15.04, 15.06, 15.09, 15.13, 15.16, & 15.19) will reduce how far downstream sediment effects travel and that effects decrease to near-background levels within approximately 1,000 feet based on inferences from this research and professional judgment.

- The Forest Service effectively uses Best Management Practices (Stone & Hess, 2016). Site-specific Best Management Practices minimize road-related sediment delivery to streams and subsequent effects to water quality and the aquatic environment (Cristan, Aust, Bolding, Barrett, & Munsell, 2016; Edwards, Wood, & Quinlivan, 2016; G. Ice et al., 2004; Seyedbagheri, 1996; Sugden, 2018; Warrington et al., 2017).

Watershed Condition – Peak Stream Flows & Stream Channel Form and Function

- Watersheds in the northern Rocky Mountains with most of their area under 3,000 feet in elevation are rain-dominated. Those between 3,000 and 4,500 feet in elevation are rain-on-snow dominated. Those over 4,500 feet in elevation are snow-dominated (U.S. Department of Agriculture, Forest Service, 2013, p. 160).
- The removal of vegetation in a forested landscape can affect stream flow via reductions in evapotranspiration and changes in snow accumulation and distribution (Callahan, 1996; Grant et al., 2008). When more than 15-19 percent of a rain-on-snow watershed or 30-45 percent of a rain-dominated watershed is harvested, there could be measurable changes to peak stream flows that have the potential to affect sensitive channel types (Grant et al., 2008; Olsen et al., 1997).
- Roads can contribute to increased peak stream flows by extending the stream network and increasing drainage efficiency (Jones & Grant, 1996; Wemple et al., 1996). Using Best Management Practices on existing roads to disconnect road segments from the stream network helps reduce contributions to peak stream flow increases (see Appendix A, BMP 15.07).
- Watersheds with lower road density and road connectivity, slower drainage efficiency, patchier forest harvest, and greater riparian area widths (that is, higher watershed condition) experience harvest levels at the higher end of the range before peak stream flow effects occur. Watersheds in a lower watershed condition experience peak stream flow effects with forest harvest levels at the lower end of the range (Grant et al., 2008; Wemple et al., 1996).
- Natural disturbances (for example, landslides, wildfire, insect and disease outbreaks) prevent a watershed from ever being 100 percent forested. Therefore, this analysis provides an overestimate of peak flow change.
- Forest harvest does not increase peak stream flows for storms with recurrence intervals longer than 6 years (Grant et al., 2008). Flows with a recurrence interval of less than 1 year are not large enough to influence the form and function of stream channels.
- The limit of detectable change to flow measurements is approximately 10 percent (Grant et al., 2008). Smaller changes are within the range of natural variability and measurement error and are undetectable.
- Peak stream flow increases do not affect steep channel types (for example, cascade and step-pool) (Grant et al., 2008). Gravel- and sand-bed channels are more susceptible to peak stream flow-related changes in channel form and function.

- Hydrologic recovery occurs gradually with substantial recovery occurring within 20 to 30 years after harvest and reforestation (Callahan, 1996). As forest stands mature, evapotranspiration and canopy processes (snowfall interception, shade, etc.) return to pre-disturbance levels. Paired watershed studies suggest that increases in annual water yield resulting from clearcutting disappear within 30 years (Julia A. Jones & Post, 2004; Perry & Jones, 2017). As a result, stands harvested 30 years ago will achieve substantial hydrologic recovery over the course of project implementation.
- Two percent of the project area is privately owned, and none of these lands are managed for timber. The effects of prior Forest Service timber harvest are accounted for in the existing condition.

Analysis Methods

Water Quality – Sediment Delivery (Hillslopes)

1. I used the Rocky Mountain Research Station Climate Generator (Rock:Clime)[8] to generate climate parameters. Rock:Clime uses PRISM, a precipitation model within the U.S. Forest Service WEPP models, to adjust precipitation and temperature based on elevation and topography from established weather station data. The model allows users to input latitude and longitude and then adjusts the climate for that location. I selected a location near the center of the project area for input into Rock:Clime.[9]
2. I used Web Soil Survey[10] to identify the dominant soil types present within treatment units.[11]
3. I used the Disturbed WEPP Batch online interface[12] to estimate average sediment delivery from treatment units for a 50-year simulation period under existing conditions[13] and after treatment.[14] Disturbed WEPP Batch is a custom online interface to the Water Erosion and Prediction Project (WEPP) runoff and erosion prediction model (NSERL, 1995). WEPP is a process-based, spatially distributed hydrology and erosion prediction model that predicts runoff, soil erosion, and sediment delivery by considering specific soil, climate, ground cover, and topographic conditions. It was developed by an interagency group of scientists including the USDA's Agricultural Research Service, Forest Service, and Natural Resources Conservation Service and the U.S. Department of the Interior's Bureau of Land Management and Geological Survey. Custom interfaces to the WEPP model (including Disturbed WEPP Batch) have been developed by the USDA Forest Service Rocky Mountain Research Station specifically to assist forest land managers in the selection and assessment of site-specific management options.

Water Quality – Sediment Delivery (Roads)

1. I used the GRAIP_Lite sediment prediction model[15] to initially identify roads within the project area that present a higher risk of delivering sediment to streams. This helped focus my attention on road segments that were most likely to benefit from the use of Best Management Practices. GRAIP_Lite is a system of tools developed for ArcGIS that is used to model road-related sediment impacts to stream habitats. GRAIP_Lite uses a topographic model, along with other inputs, to create road segments, applies average vegetation parameters and calculates sediment production from individual road segments, uses a local polynomial fit to describe stream connection probabilities and fractional sediment delivery based on flow distance to streams,

and accumulates routed sediment throughout the modeled stream network. The output (specific sediment; Megagrams per year per kilometer^2) can easily be used to determine areas where roads are more likely to contribute excess sediment to stream habitats.

2. I conducted field work from July 15th to July 18th, 2019. I travelled the road system (with an emphasis on road segments identified in Step 1 above), documenting the location and condition of sediment delivery points to streams, photographing delivery points, and prescribing conditions-based, site-specific Best Management Practices to minimize road-stream interactions.[16]
3. I used the WEPP:Road Batch online interface[17] to estimate average sediment delivery from stream crossings on reconstructed roads during log haul.[18] WEPP:Road Batch is another custom online interface to the WEPP model.
    a. I modeled reconstructed road prisms as outsloped, rutted, and 16 feet wide. I calculated road gradient using LiDAR-derived elevation data. The climate and soils data used were the same used for estimating Hillslope Sediment Delivery as discussed above. I modeled traffic level as "high" to simulate log haul during project implementation. Finally, I assumed that all sediment generated by road segments would be delivered to streams (that is, none would be deposited in buffers between the road surface and stream) using a methodology outlined by Elliot, Hall, and Scheele (1999).
    b. Although the method used to model sediment delivery to streams ignores erosion from fillslopes, the alternate method likely overestimates sediment deposition on the fillslope and buffer. Modeling road segments as all being outsloped, rutted, and 16 feet wide overestimates actual surface erosion since some road segments are insloped with vegetated ditches and most are less than 16 feet wide. The model assumes that all road segments are rutted and that ruts leave the road prism directly over stream crossings. However, stream crossings are not always the low point on the road segment, and ruts may deliver sediment to the forest floor below the crossing, substantially reducing sediment delivery. Additionally, in its calculation of sediment production, the model assumes that all reconstructed road segments across the project area would be heavily used at the same time and on a year-round basis. In reality, road use would be staggered spatially and temporally throughout time (since each timber sale would occur over multiple years and timber sales would not all be implemented at the same time), and roads would only be used during the portion of the year when they are not so wet that excessive erosion and sediment delivery would occur. For these reasons, I believe that any fillslope erosion that is ignored by the model is more than offset by modeling this "worst-case scenario" for road conditions and haul and that the modeled estimates are higher than reality.

Watershed Function – Peak Stream Flows & Stream Channel Form and Function

1. I categorized watersheds as rain-dominated, rain-on-snow dominated, or snow-dominated based upon their dominant elevation range, which was determined using a LiDAR bare earth elevation model.

2. I used information from the FACTS database to identify areas where timber harvest and prescribed fire have occurred on Forest Service lands since 1990, and I categorized these areas as “open.”[19]
3. I used the R1 VMap model to identify areas not categorized as primarily forested (that is, herbs, shrubs, water, sparsely vegetated) and categorized these areas as “open.” This status was verified using 2017 aerial imagery.
4. I used the Forest Service Infra database to identify existing roads and applied a 20-foot buffer on each side of the road (40-foot width total). This width was chosen after estimating the average width of road openings using aerial imagery. I categorized the resulting polygons as “open.”
5. I merged the results of Steps 2 through 4 together and dissolved them to eliminate the double-counting of overlapping areas.
6. I calculated the “open” area within the watershed as a proportion of the total watershed area.
7. I compared this “open” proportion to the maximum reported change line from the appropriate envelope curves in Grant et al. (2008, p. 35) to estimate the upper bound of potential change from “natural” conditions, with a lower bound of no response.
8. I adjusted the “open” proportion of each watershed to account for proposed timber harvest and temporary road construction. I compared this new proportion to the maximum reported change line from the appropriate envelope curves to estimate a new upper bound of potential change from “natural” conditions. The difference in the outputs of Steps 7 and 8 makes up the direct or indirect effects of timber harvest.
9. I adjusted the “open” proportion of each watershed once more to account for reasonably foreseeable timber harvest and the hydrologic recovery of lands harvested between 1990 and 2000. I compared this new proportion to the maximum reported change line from the appropriate envelope curves to estimate a final upper bound of potential change from “natural” conditions. The difference in the outputs of Steps 7 and 9 makes up the cumulative effects of the timber harvest with present and reasonably foreseeable actions.
10. If the estimated change in peak stream flows from Step 9 was detectable (10 percent or more), I identified stream reaches most likely to be affected by changes to bank stability and the frequency of sediment transport and depth of scour (gravel- and sand-bed; 2 percent gradient or less [(Grant et al., 2008; Montgomery & Buffington, 1997)]) using GIS and the LiDAR-derived bare earth elevation model.

Description of the Bounds Used for the Effects Analysis

Spatial Boundary

I analyze direct, indirect, and cumulative effects at the scale of the reference reaches described in the Forest Plan (Appendix K). This ensures that the effects of the proposed activities are analyzed at the scale of the stream systems used in the Forest Plan and encompass not only the steep, headwater streams at the project site but also the lower-gradient stream reaches where effects are most likely to occur. Both increased sediment and peak stream flows have greater effects to water quality in the gentle, downstream reaches where aquatic habitat is concentrated than in steep, headwater streams. This scale is somewhat smaller than those used by the Idaho Department of Environmental Quality when developing Total Maximum Daily Loads for impaired waterbodies. A broader scale makes it increasingly unlikely that the effects of proposed activities are detectable. The project lies primarily within the 17,700-acre Pete King Creek subwatershed.[20] All proposed timber harvest, prescribed fire, and temporary road construction within 300 feet of streams would occur there as well as the majority of road reconstruction and road maintenance within 300 feet of streams (Table 3). Since most proposed activities would occur within catchments in the Pete King Creek subwatershed and the remainder of activities would be spread over multiple subwatersheds, this analysis will focus on Pete King Creek and its major tributaries. It is very unlikely that the limited extent of activities in other subwatersheds would result in detectable effects.

Table 3. Proportion of proposed activities occurring in each subwatershed

	Pete King Creek Subwatershed	**Big Smith Creek-Middle Clearwater River Subwatershed**	**Canyon Creek Subwatershed**	**El Dorado Creek Subwatershed**	**Glade Creek-Lochsa River Subwatershed**	**Middle Lolo Creek Subwatershed**
Timber Harvest	100 percent	--	--	--	--	--
Prescribed Fire	100 percent	--	--	--	--	--
Temporary Road Construction[21]	100 percent	--	--	--	--	--
Road Reconstruction[21]	69 percent	6 percent	less than 1 percent	--	19 percent	6 percent
Road Maintenance[21]	68 percent	18 percent	less than 1 percent	less than 1 percent	--	14 percent

Temporal Boundary

The temporal boundary for analysis is 30 years from the completion of all timber harvest, which allows sufficient time for vegetation to regenerate to the point where hydrologic processes have recovered (Callahan, 1996). However, sediment-related effects recover more quickly (within 2-3 years from the completion of activities) as vegetation regenerates, soil is stabilized, and erosion quickly returns to background levels (Elliot & Robichaud, 2001; Luce & Black, 1999; Luce & Black, 2001).

Description of Activities Considered in the Analysis of Cumulative Effects

I considered the following past, present, and reasonably foreseeable actions during the cumulative effects analysis for water quality and watershed condition. Only activities with effects that overlap the spatial and temporal boundaries of the Pete King Wildlife Habitat Restoration project as described above were considered. Some of these items are discussed in greater detail in the “Existing Conditions” section below.

- Ongoing aquatic habitat restoration work including the replacement of fish passage barriers with Aquatic Organism Passage (AOP) structures (for example, recent installation of an AOP where Forest Service Road 418 crosses Pete King Creek)
- Projects authorized by the North Lochsa Face Record of Decision (includes timber harvest, prescribed fire, road obliteration, road storage, removal of sediment traps in Walde and Pete

King Creeks, and riparian planting along Pete King Creek; includes the Where's Walde, Polar Ice Stewardship, and Cabin Stewardship projects)
- Projects authorized by the Interface Fuels II Decision Notice (includes timber harvest and prescribed fire)
- Wildfire and fire suppression activities
- Recreational activities (for example, hunting, fishing, dispersed camping, OHV trail use)
- Road maintenance activities
- Firewood cutting – generally prohibited within Riparian Habitat Conservation Areas

Existing Conditions

Beneficial Uses and Water Quality Status

Beneficial uses and water quality criteria and standards are identified in the State of Idaho Water Quality Standards and Wastewater Treatment Requirements.[22] Designated beneficial uses include cold water aquatic life and secondary contact recreation for Pete King Creek and its tributaries and salmonid spawning for Pete King Creek from its mouth to Walde Creek.[23] Pete King Creek from its source to Walde Creek supports its beneficial uses; however, Walde Creek and Pete King Creek downstream of its confluence with Walde Creek are listed as water quality limited for temperature in the 2016 IDEQ 303(d)/305(b) Integrated Report (Steimke, 2018). The Idaho Department of Environmental Quality developed an approved Total Maximum Daily Load for this impairment in 2012 (State Technical Services Office, 2012).

Stream Channel Characteristics

Pete King Creek has a unique geology that contributes to high levels of instream sediment. The tendency is for sediment to increase and deposit at a faster rate than streamflow can remove it. The stream, therefore, has a tendency to be sediment surplus and energy limited.[24] Cobble embeddedness data collected near the mouth of Pete King Creek since 1997 has varied with values ranging from 29 to 71 percent.[25] Cobble embeddedness measured during the summer of 2019 was 50 percent,[26] which exceeds the Desired Future Condition criteria.[27] However, data from several sources discussed below suggests that sediment conditions within the subwatershed are trending in the right direction.

Long-term Forest Service sediment monitoring in Pete King Creek indicates an overall decreasing trend in percent fines in suitable steelhead spawning habitat from 1985 to 2014.[28] Likewise, although not specific to Pete King Creek, Archer and Ojala (2016) found that stream habitat conditions in the Lochsa River subbasin generally improved between 2001 and 2015. During this time period, many habitat metrics including macroinvertebrate scores, bank stability, percent undercut banks, and large wood frequency improved. Although not statistically significant, median substrate size and percent fines in pool tails improved as well. These findings are similar to those recently reported by Roper et al. (2019) demonstrating that maintaining Riparian Habitat Conservation Areas improves salmonid habitat conditions. Additionally, stream data collected by the Idaho Department of Environmental Quality's Beneficial Use Reconnaissance Program shows that index scores for stream macroinvertebrates, fish, and stream habitat improved in portions of Pete King Creek between 1996 and 2010.[29]

Water Quality – Sediment Delivery

The natural sediment production rate for the Pete King Creek subwatershed is 23 tons per mile^2 per year.[24] Table 4 shows the estimated annual sediment production for streams within the subwatershed. Disturbed WEPP modeling estimates that annual sediment delivery to streams from hillslope erosion is currently 0.01 ton per acre.[13]

Table 4. Sediment production for streams within the Pete King Creek subwatershed

Stream	Area (miles^2)	Annual Sediment Production (tons per year)
Pete King Creek below West Fork Pete King Creek	27.5	633
West Fork Pete King Creek	7.5	173
Walde Creek	7.0	161
Placer Creek	2.4	55
Nut Creek	2.4	55

Streams in the Pete King Creek subwatershed were assessed in 2002 and found to be meeting the Forest Plan water quality standards and percent sediment yield over natural conditions criteria (Table 5).[30] Table 6 shows the Forest Service management activities and wildfire occurrence since 2002. Of the 892 acres of harvest that has occurred on Forest Service lands, 16 acres consisted of single-tree selection, 126 acres of commercial thinning, and 750 acres of regeneration harvest.[31] Satellite imagery of prescribed burn areas shows minimal tree mortality, suggesting low burn severity prescribed fire, which would have negligible effects on erosion and sediment delivery. The Forest Service has decommissioned or abandoned approximately 55 miles of system roads since 1997,[32] which includes a combination of blocking roads, decompacting surfaces, outsloping, waterbarring, and culvert removal depending on the needs of the specific road segment. Decommissioning or abandoning roads minimizes direct connections to the stream network and reduces sediment delivery to near-background levels.

Table 5. Water quality criteria and condition for streams within the Pete King Creek subwatershed

Stream[33]	Channel Type[34]	Standard[34]	Max Allowable Sediment Yield Percent Over Natural			Watershed Condition[27]
			Forest Plan Standard[34]	Existing Condition[30]	Allowable Yrs. in 30 Exceeding Threshold[34]	
Pete King Creek below West Fork Pete King Creek	B	High Fishable	55 percent	19 percent	10	Moderate
West Fork Pete King Creek	B	High Fishable	55 percent	33 percent	10	Moderate
Walde Creek	B	High Fishable	55 percent	48 percent	10	Moderate
Placer Creek	A	High Fishable	110 percent	2 percent	10	Moderate
Nut Creek	A	High Fishable	110 percent	0 percent	10	Moderate

Table 6. Forest Service management activities and wildfire occurrence since 2002 in the Pete King Creek subwatershed

Watershed	Area (ac)	Past Harvest[35]		Past Prescribed Fire[35]		Past Wildfire[36]	
		Acres	percent of Watershed	Acres	percent of Watershed	Acres	percent of Watershed
Pete King Creek	17,630	876	5 percent	582	3 percent	429	2 percent

Watershed Function – Peak Stream Flows & Stream Channel Form and Function

16 percent of the Pete King Creek subwatershed is currently in an "open" condition.[37] As a result, modeled peak stream flows are 10 percent higher than if the entire area was forested. This is an over-estimate for the reasons described in the "Analytical Assumptions" and "Analysis Methods" sections above. Even so, monitoring data from 2004 to 2014 found Pete King Creek to have highly stable stream banks (greater than 90 percent).[38] Lower Pete King Creek has a Relative Bed Stability index value of between 1.3 and 3.2[39] indicating that there is a relatively low likelihood that channel instability would occur as a result of additional small peak stream flow increases.[40]

Thresholds for the Analysis of Environmental Effects

Water Quality – Sediment Delivery

The Clearwater Forest Plan contains management direction to maintain high quality water that meets or exceeds State and Federal water quality standards and to protect all beneficial uses of the water (USDA Forest Service, 1987, p. II-3). Forest Plan Standards include managing water quality and stream conditions to assure that activities do not cause permanent or long-term damage to existing or specified beneficial uses and applying best management practices to ensure water quality standards are met or exceeded (USDA Forest Service, 1987, p. II-27). Appendix K in the Forest Plan lists the water quality criteria applicable to specific stream systems across the Forest, and Table 5 shows the subset of streams located near the project area. Although Pete King Creek meets the Forest Plan water quality criteria in Appendix K, it does not meet the Desired Future Condition for cobble embeddedness, and the Proposed Action is therefore subject to no measurable increase in sediment in accordance with the 1993 Forest Plan Stipulation Agreement[41] (see the "Consistency with Regulatory Framework" section below).

Streams in the Pete King Creek subwatershed are not listed by the Idaho Department of Environmental Quality as impaired by sediment in Idaho's 2016 §305(b) Integrated Report (Steimke, 2018) but are subject to the state's anti-degradation policy.[42]

Watershed Function – Peak Stream Flows & Stream Channel Form and Function

The Forest Plan does not establish thresholds for changes to peak stream flows. However, the Forest Plan Standards include securing favorable conditions of flow by maintaining the integrity and equilibrium of all stream systems and managing stream conditions to assure that activities do not cause permanent or long-term damage to existing or specified beneficial uses (USDA Forest Service, 1987, p. II-27).

Environmental Effects and Conclusions

Alternative 1 – No Action

Under the No Action alternative, there would be no timber harvest, site preparation, prescribed fire, or road activities as described under the Proposed Action. Regularly scheduled road maintenance would continue to occur on the existing road network.

Effects to Water Quality – Sediment Delivery

Sediment contributions from roads would remain unchanged from the existing condition. While periodic road maintenance would occur on some roads as part of the ongoing road maintenance program, due to very limited budgets, the amount and intensity of maintenance activities would be substantially less than under the Proposed Action. Roads would continue to act as chronic sources of sediment to streams, and undersized or failing culverts would continue to degrade stream channels and aquatic habitat. As a result, the No Action alternative could result in more sediment delivery from roads as well as a higher risk of culvert failures than the Proposed Action.

Effects to Watershed Function – Peak Stream Flows & Stream Channel Form and Function

Under the No Action alternative, peak stream flows would not immediately change and would decrease as past harvest units throughout the subwatershed continue to recover. This is unlikely to affect stream channel form and function since changes to peak stream flows appear to contribute relatively little to channel stability or instream sediment dynamics (Safeeq et al., 2020).

Alternative 2 – Proposed Action

Effects to Water Quality – Sediment Delivery

Environmental Effects of Temporary Road Construction

The effects of temporary road construction to water quality would be minimal because of the lack of hydrologic connection between temporary roads and streams and the limited amount of time that they would exist on the landscape. Temporary roads would not enter Riparian Habitat Conservation Areas or cross streams. Sediment from temporary road construction would be controlled using Best Management Practices such as maintaining the road surface to provide proper drainage and prevent excessive erosion (Appendix A; BMPs 15.02, 15.06, & 15.09) and suspending construction and haul during wet conditions (BMPs 15.04 & 15.23). Within 5 years of project completion (including site preparation and planting), temporary roads would be rendered hydrologically stable through recontouring or obliteration (BMP 15.25). Recontouring or obliterating 0.6 mile of temporary road built on existing road prisms would be a slight benefit to water quality and watershed function that would not occur under the No Action alternative.

Environmental Effects of Road Maintenance, Reconstruction, and Haul

Approximately 37 miles of system roads would be maintained to improve road drainage and reduce sediment delivery to streams. This would include a combination of brushing, blading, the addition of gravel to driving surfaces, and drainage improvements. Road maintenance would improve drainage by replacing, upgrading, or installing new culverts, and or cleaning and armoring ditches where necessary. Failing and severely undersized stream crossing culverts would be replaced with culverts sized to pass a 100-year flow with allowance for bedload and debris (see Design Features), reducing long-term chronic sediment delivery and the risk of road fill failures. The addition of gravel to rutted or otherwise damaged road surfaces would reduce sediment production and subsequent delivery to streams.

Approximately 21 miles of roads that are currently in a stored condition would be reopened or reconstructed during project implementation and then placed back into storage upon project completion. These roads are currently in a heavily vegetated condition with few signs of active erosion. In order to facilitate vehicle traffic, they would have their surface bladed and the vegetation removed, which would increase erosion from the driving surface. However, sediment delivery to streams would be minimized using Design Features and Best Management Practices. By installing a ditch relief culvert, rolling dip, or other similar drainage structure before each stream crossing, sediment delivery to streams would be limited to an average of 65 pounds per stream crossing per year.[18] Table 7 below shows the total modeled sediment delivery for each catchment and the proportion of natural sediment production that this represents. These numbers overestimate sediment delivery (see "Analytical Methods" section above) and are representative of conditions during project implementation when reconstructed roads would experience high traffic volumes. Once these roads are returned to a stored condition, eliminating vehicle traffic, adding more frequent drainage structures (such as waterbars), and an increase in road surface vegetation would virtually eliminate long-term sediment delivery.

Table 7. Sediment delivery from reconstructed stream crossings

Stream	Sediment Delivery (tons per year)	Sediment Delivery (tons per acre per year)	percent Increase Over Natural
Pete King Creek below West Fork Pete King Creek	1.4	less than 0.01	0.2 percent
West Fork Pete King Creek	0.5	less than 0.01	0.3 percent
Walde Creek	0.4	less than 0.01	0.2 percent
Placer Creek	0.03	less than 0.01	0.1 percent
Nut Creek	0.1	less than 0.01	0.2 percent

Although maintenance and reconstruction activities could increase sediment production in the short-term (that is, days to weeks), Design Features and Best Management Practices would be used to achieve the Riparian Management Objectives and meet the intention of the Idaho Forest Practices Act[43] and the Soil and Water Conservation Handbook.[44] Design Features would reduce long-term sediment delivery to streams by routing road drainage away from streams, prohibiting sidecasting of soil, and using erosion and sediment control measures to minimize sediment delivery to streams from road work. Examples of Best Management Practices (BMPs) to minimize sediment delivery include end hauling waste material out of Riparian Habitat Conservation Areas (Appendix A; BMP 15.10), suspending road-related activities including haul when conditions would cause degradation of the road surface (BMPs 15.04 & 15.23), applying erosion and sediment control to disturbed areas (BMP 15.06), maintaining the road surface and improving road drainage to prevent excess erosion (BMP 15.07 & 15.21), maintaining ditches and culverts in a functional state (BMP 15.21), and minimizing ground disturbance in riparian areas (BMPs 15.12, 15.13, & 15.16). The long-term benefits of improving drainage and armoring road surfaces would outweigh any short-term increases in sediment delivery. Although the exact locations of culvert installations are not known, a review of GIS data (stream location modeling, topographic information, aerial photos, U.S. Geological Survey PRObability of Streamflow PERmanence [PROSPER] modeling[45]) suggests that affected streams would most likely be headwater or first order streams that are either intermittent or have a small amount of perennial flow. Using Best Management Practices related to culvert installation (BMP 15.16) would minimize sediment production and mobilization and prevent effects from extending beyond 1,000 feet downstream. Culvert installations would be spread apart spatially and occur as a part of multiple timber sales (over several years), which would lessen the magnitude of effects and cause any increase in sediment to be negligible at the mouths of the affected stream systems (for example, Walde Creek or Placer Creek).

Numerous studies document that site-specific Best Management Practices minimize road-related sediment delivery to streams from road construction, maintenance activities, and log haul (Arismendi et al., 2017; Cristan et al., 2016; Edwards et al., 2016; G. Ice et al., 2004; Seyedbagheri, 1996; Sugden, 2018; Warrington et al., 2017). Minimizing sediment delivery reduces the effects of management activities on water quality and the aquatic environment. Monitoring shows that the Forest Service effectively uses best management practices (Stone & Hess, 2016) and that implementation rates in Idaho are high (Cristan, Michael Aust, Chad Bolding, Barrett, & Munsell, 2018; G. G. Ice, Schilling, & Vowell, 2010). The widespread application of Best Management Practices over time appears to lead to watershed-scale improvements in water quality (Reiter, Heffner, Beech, Turner, & Bilby, 2009). As a result, although there would be short-term, localized sediment delivery focused around stream crossings, sediment delivery from road-related activities would be undetectable at the mouth of Pete King Creek and its major tributaries and have a negligible effect on water quality.

Environmental Effects of Gravel Pit Use

The Proposed Action would use commercial sources and or the existing Jungle Point gravel pit adjacent to Forest Service Road 5513 as an aggregate source for road maintenance, reconstruction, and construction activities. The use of this pit would not affect sediment delivery to streams because the pit is well away from streams and other waterbodies. The access road would also be used for log haul from nearby units and would have maintenance performed to minimize sediment delivery to streams along the route.

Environmental Effects of Timber Harvest and Site Preparation Activities

Modeling results from Disturbed WEPP estimate that timber harvest and site preparation treatments would increase sediment delivery to streams by 0.04 ton per acre in the first year post-activity with the percent chance of predicted sediment delivery ranging from 0 to 46 percent.[14] This is an overestimate (see Analytical Assumptions section above). Sediment delivery would return to background levels within 2 to 3 years (Elliot & Robichaud, 2001). Sediment delivery less than 0.5 ton per acre per year is considered undetectable and negligible (W.J. Elliot, USFS Rocky Mountain Research Station, as cited in Traeumer, 2018). A growing body of research supports the conclusion that timber harvest carried out with vegetated stream buffers and Best Management Practices results in minimal sediment delivery to streams (Karwan, Gravelle, & Hubbart, 2007; Litschert & MacDonald, 2009; Rashin et al., 2006). Best Management Practices include (but are not limited to) timing restrictions to ensure that project activities only occur when soils are not saturated (see Appendix A ; BMPs 14.04 & 14.12), excluding areas from treatment that have a high risk of mass failure (see Design Features; BMP 14.05), controlling erosion from landings (BMPs 14.10 & 14.11), and constructing waterbars on skid trails or yarding corridors that are likely to deliver sediment to streams (BMPs 14.12 & 14.15). Additionally, Design Features would require the full suspension of logs when yarding over streams (when practicable) and the scarifying and recontouring of skid trails where water resources or soil productivity may be impacted. Since I assume that timber harvest would retain the minimum number of trees possible, the creation of openings larger than 40 acres in size would not have effects beyond those already analyzed.

Environmental Effects of Prescribed Burning

There would be a slight increase in sediment delivery from prescribed fire treatment units of 0.07 ton per acre in the first year post-activity with the percent chance of predicted sediment delivery ranging from 44 to 52 percent.[14] As discussed earlier, sediment delivery less than 0.5 ton per acre per year is considered undetectable and negligible (W.J. Elliot, USFS Rocky Mountain Research Station, as cited in Traeumer, 2018). The surface condition after a prescribed fire is typically a mosaic-like pattern of low-severity, high-severity, and unburned patches (Robichaud, 2000). The patterns of burn severity help control the spatial scale at which the effects of prescribed burning can be detected.[46] The patchiness of burn severity allows unburned and low-severity patches to infiltrate runoff and trap sediment that is generated on adjacent high-severity patches (Biswell & Schultz, 1957; Cooper, 1961; Swift, Elliott, Ottmar, & Vihnanek, 1993). Mitigation Measures would prohibit the ignition of prescribed fire in Riparian Habitat Conservation Areas.[3] Design Features would require that prescribed fire within Riparian Habitat Conservation Areas meet Riparian Management Objectives and have minimal impacts on stream shading and sedimentation.[2] This would limit the fire severity and subsequent consumption of litter and reduction of surface roughness which traps sediment before it is delivered to the stream. The intensity of fire within Riparian Habitat Conservation Areas would be less than in upland areas due to the increased shade, humidity, and fuel moistures found there. The results would be generally beneficial. Dwire and Kauffman (2003) reported that prescribed fire may kill certain riparian trees and shrubs but is unlikely to negatively affect below-ground structure. The bank-stabilizing properties of riparian vegetation would be preserved, and vegetation would recover quickly. Specific criteria in the burn plans would limit the severity of fires such as: constraints on fuel, duff, and soil moistures; weather conditions, such as relative humidity; areas to exclude ignition; etc. Fire intensity would be controlled and adjusted during implementation by modifying the pattern of ignition. Additionally, burns would be initiated either in the spring when conditions are relatively wet or a short time before wet weather is expected in the fall. Prescribed fire treatment units would be completed in pieces as favorable burning conditions occur.

Effects to Watershed Function – Peak Stream Flows & Stream Channel Form and Function

Timber harvest and temporary road construction would increase peak stream flows by 5percent over existing conditions.[37] This figure assumes worst-case-scenario watershed conditions including road density, road connectivity, drainage efficiency, and harvest intensity on the high end of the spectrum and narrow riparian buffers. Road-related watershed condition indicators (for example, open road density, road maintenance, proximity to water) are rated as "poor" in the Watershed Condition Class and Prioritization Information database and seem to fit this assumption.[47] However, Riparian Habitat Conservation Areas are at the wider end of the spectrum[48] and harvest intensity falls somewhere on the less-intense end.[49] Increases in peak stream flows of this magnitude as a result of timber harvest and temporary road construction would be undetectable and would last 20 to 30 years where reforestation occurs (Callahan, 1996; Grant et al., 2008). Reforestation would occur within a few years for all harvest units within Management Area E1. Harvest units within Management Area C4 would be allowed to revegetate naturally, and peak stream flows in these areas may take substantially longer to return to pre-project levels. There is no current or reasonably foreseeable timber harvest to consider on public or private lands within the analysis area that would further affect peak stream flows. Currently, peak stream flows are 10 percent above natural conditions due to prior timber harvest, road building, and wildfire; therefore, proposed harvest would increase peak stream flows up to 16 percent above natural conditions. However, 1,055 acres of timber harvest occurred between 1990 and 2000; these lands will reach hydrologic maturity during project implementation and would limit overall peak stream flow increases to 14 percent over natural conditions. This is above the detection limit identified by Grant et al. (Grant et al., 2008) and indicates that the potential exists for increased peak stream flows to affect stream channel form and function. However, prior research fails to show a link between timber harvest and changes to stream channel form and function,[5] and recent research indicates that effects to stream channels from increased peak stream flows is minimal even in 100 percent clearcut drainages (Safeeq et al., 2020). Any effects would be largely restricted to lower-gradient stream reaches (less than 2 percent) which primarily occupy the lower 3 miles of Pete King Creek and 2 additional brief, low-gradient reaches (less than 0.25 mile each) higher along Pete King Creek.[50] The project hydrologist and fisheries biologist assessed these reaches between July 15th and July 18th 2019 and determined that they are currently stable and functioning properly despite the current modeled elevated peak stream flows.[51] Since I assume that timber harvest would retain the minimum number of trees possible, the creation of openings larger than 40 acres in size would not have effects beyond those already analyzed.

Conclusions and Cumulative Effects

Under the Proposed Action, timber harvest and site preparation treatments, prescribed fire, and road-related activities would slightly increase sediment delivery to streams for 2-3 years (Elliot & Robichaud, 2001; Charles H. Luce & Black, 1999; C. H. Luce & Black, 2001). Timber harvest and prescribed fire would increase sediment delivery by an average of 0.05 ton per acre per year. The impacts of road maintenance, reconstruction, and log haul on water quality would be minimal with the use of Design Features and Best Management Practices and increase sediment delivery by an additional 0.01 ton per acre per year. Increases in sediment delivery would be undetectable at the mouths of Pete King Creek and its major tributaries and would have a negligible effect on water quality. Gravel pit use would not affect water quality. Timber harvest, prescribed fire, and temporary road construction would contribute toward a 5 percent increase in peak stream flows above current conditions in Pete King Creek.

Stream and aquatic habitat conditions in Pete King Creek and the Lochsa River basin have improved since the adoption of vegetated buffers and forestry-related Best Management Practices. Restoration work including riparian planting, removal of sediment traps on Pete King and Walde Creeks, construction of beaver dam analogs, and replacement of culverts that acted as fish passage barriers also helped improve conditions. Improvements in stream and aquatic habitat conditions occurred despite continued active management of the watershed under the North Lochsa Face and Interface Fuels II timber harvest and fuels treatment projects. No other timber harvest, prescribed fire, or road building activities would occur concurrently with the Proposed Action or are reasonably foreseeable. When considering other present and reasonably foreseeable activities, water quality and aquatic habitat would continue to improve during implementation of the Proposed Action. Timber harvest, prescribed fire, and temporary road construction would contribute toward a 14 percent cumulative increase in peak stream flows above natural conditions. This increase would exceed the detection limit of 10 percent but would not be enough to alter the stability or function of stream channels. Stream banks are currently very stable, sediment conditions under current elevated peak stream flow conditions have continued improving, and Relative Bed Stability index values (a measure of channel stability) are moderate – all indicating that a slight increase in peak stream flow magnitude would have a negligible effect on stream channel form and function.

Consistency with Regulatory Framework

I have reviewed the Proposed Action and determined that it complies with the management framework applicable to water resources. The laws, regulations, policies, and forest plan direction applicable to this project and resources are as follows:

Land and Resource Management Plan

Clearwater Forest Plan

The Forest Plan contains several standards that projects must comply with relating to water quality and quantity:

- "Secure favorable conditions of flow by maintaining the integrity and equilibrium of all stream systems in the Forest" (p. II-27). Under the Proposed Action, timber harvest and temporary road construction would contribute toward a 14 percent cumulative increase in peak stream flows above natural conditions. The stability of stream banks, improving sediment conditions within the affected stream reaches under current elevated peak stream flow conditions, and moderate Relative Bed Stability index values indicate that a temporary (20-30 year), undetectable increase in peak stream flow magnitude would have a negligible effect on stream channel form and function. Effects to stream channels in the C4 Management Area where reforestation may occur more slowly would last longer but still have a negligible effect. See the "Environmental Effects and Conclusions, Alternative 2 – Proposed Action, Effects to Watershed Function – Peak Stream Flows and Stream Channel Form & Function" section above for more information.
- "Manage water quality and stream conditions to assure that National Forest management activities do not cause <u>permanent or long-term damage</u> to existing or specified <u>beneficial uses</u>" (p. II-27). Under the Proposed Action, timber harvest and site preparation treatments, prescribed fire, and road-related activities would slightly increase sediment delivery to streams for 2-3 years. Increases in sediment delivery would be undetectable at the mouths of Pete King Creek and its major tributaries and would have a negligible effect on water quality. See the

"Environmental Effects and Conclusions, Alternative 2 – Proposed Action, Effects to Water Quality – Sediment Delivery" section above for more information.

- "Apply best management practices (BMPs) to project activities to ensure water quality standards are met or exceeded (See Soil and Water Conservation Handbook in Forest Service Handbook 2509.22)" (p. II-27). Best Management Practices would be applied to project activities. See the Design Features.[2]
- "Manage all waters in the Forest under a basic standard [Maximum temporary reduction of water quality for any specified beneficial uses. It must continue to maintain the stability, equilibrium, and function (physical and biological) of a tributary stream as it relates to the beneficial uses of local, downstream, and parent stream. The water quality and stream conditions must be fully recoverable in time. This standard is applicable to all streams and may be supplemented by the standards listed below that apply to fish habitat. For individual projects, the beneficial uses must be identified, and the criteria to protect these uses must be specified]" (pp. II-27 & K-2). As stated above, water quality and stream form and function would be maintained under the Proposed Action, which would protect the identified beneficial uses.
- In addition to the basic standard, manage streams in the project area to meet the High Fishable standard: "Maximum short-term reduction of water quality that is still likely to maintain a fish habitat potential that can support an excellent fishery relative to the stream system's natural potential, and that will provide the capability for essentially full habitat recovery over time. Maximum short-term sediment loading that is not likely to cause more than a 20 percent reduction from full biological potential of the habitat for the appropriate fish indicator species. Threshold levels of sediment should not be exceeded for more than 10 out of 30 years" (p. K-3). As stated above, water quality and stream form and function would be maintained under the Proposed Action. Any increase in sediment delivery to streams would be undetectable within the identified reference reaches.
- "Design, schedule, and implement management practices at the project level that: (1) will maintain water quality and stream conditions that are not likely to cause sustained damage to the biological potential of the fish habitat, (2) will not reduce fish habitat productivity in the short-term below the assigned standards, (3) will maintain water quality in a condition that is not likely to inhibit recovery of the fish habitat for more than the stated duration, and (4) will require a watershed cumulative effects feasibility analysis of projects involving significant vegetation removal, prior to including them on implementation schedules, to ensure that the project, considered with other activities, will not increase water yields or sediment beyond acceptable limits. Also require that this analysis identify any opportunities for mitigating adverse effects on water-related beneficial uses, including capital investments for fish habitat or watershed improvement" (pp. II-28 & II-29). As stated above, Best Management Practices would be applied to project activities to maintain water quality and aquatic habitat. Additionally, maintaining Riparian Habitat Conservation Areas would limit the effects of the Proposed Action to water resources. A cumulative effects analysis was conducted to determine potential effects to water quality and quantity. See the "Environmental Effects and Conclusions, Alternative 2 – Proposed Action, Conclusions and Cumulative Effects" section above.

- "Conduct nonpoint source activities in accordance with applicable best management practices as referenced in Idaho Water Quality Standards and Wastewater Treatment Requirements; and in Soil and Water Conservation Handbook in the Forest Service Handbook 2509.22" (p. II-29). As stated above, Best Management Practices would be applied to project activities.

Forest Plan Stipulation Agreement

Litigation on the Forest Plan resulted in a 1993 Stipulation Agreement that discusses what type of activities the Forest could proceed with and under what conditions.[41] The Agreement states "The Forest Service agrees to proceed only with those projects that would result in no measurable increase in sediment production in drainages currently not meeting Forest Plan standards." Riparian Habitat Conservation Areas would provide a vegetative filter strip adjacent to the proposed timber harvest and prescribed fire activities, minimizing sediment delivery to streams. Design Features and site-specific Best Management Practices (see Appendix A) would minimize sediment delivery from road-related activities and reduce sources of chronic and long-term sediment delivery to streams. As a result, sediment delivery from the proposed forest management and road-related activities would be undetectable and meet the conditions of the Stipulation Agreement.

Federal Law

Clean Water Act

The Clean Water Act requires that the states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. Stipulations in the Clean Water Act require the Environmental Protection Agency and the States to develop plans and objectives that will eventually restore identified stream segments of concern. The Clean Water Act requires all water bodies that are deemed to be not fully supporting their beneficial uses by the state (Idaho) to be brought onto the 303(d) list as water quality limited. For waters identified on this list, states must develop a Total Maximum Daily Load for the pollutants set at a level to achieve water quality standards.

Timber harvest, site preparation activities, prescribed fire treatments, and road-related activities were designed to maintain stream shading and minimize the delivery of fine sediment to streams through the application of Riparian Habitat Conservation Areas, Design Features, and Best Management Practices (see Appendix A) and comply with the Clean Water Act. Site-specific Best Management Practices in the Pete King Creek watershed would reduce road-related sources of chronic and long-term sediment delivery to Pete King Creek and its tributaries, which would comply with Idaho's anti-degradation policy. Instream activities (that is, culvert installation or replacement) would meet the turbidity requirements of the state Water Quality Standards.[52] Riparian Habitat Conservation Areas would maintain shade-producing vegetation over streams, thereby complying with the Lochsa River Subbasin Temperature Total Maximum Daily Loads (State Technical Services Office, 2012).

National Forest Management Act

Section 6 of the National Forest Management Act provides language to "insure that timber will be harvested from National Forest System lands only where soil, slope, or other watershed conditions will not be irreversibly damaged; protection is provided for streams, stream-banks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat; and that such [harvests] are carried out in a manner consistent with the protection of soil, watershed, and fish resources."

Timber harvest, site preparation activities, prescribed fire treatments, and road-related activities were developed to maintain stream and watershed conditions by incorporating PACFISH Riparian Management Objectives, Riparian Habitat Conservation Areas, Design Features, and Best Management Practices to maintain water quality and channel processes and comply with the National Forest Management Act.

Executive Orders

Executive Orders 11988 and 11990

Executive Order 11988 (Protection of Floodplains)[53] requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Executive Order 11990 (Protection of Wetlands)[54] directs federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

The Proposed Action is consistent with the executive orders regarding floodplains and wetlands. This project does not propose development within wetlands or floodplains. Further, it incorporates specific Design Features and Best Management Practices (see Appendix A)**Error! Bookmark not defined.** that would protect these resources.

State and Local Law

Idaho Forest Practices Act

The Idaho Forest Practices Act regulates forest management on all ownerships in Idaho, including National Forest System lands (Title 38, Chapter 13, Idaho Code 2000). The Forest Service has agreements with the state to use best management practices for all management activities.[55]

Best Management Practices are included in the Proposed Action, and all activities would comply with the Idaho Forest Practices Rules[43] and the guidelines in the Soil and Water Conservation Handbook.[44] A recent audit of best management practices pertaining to water quality indicates that the Forest Service averaged 99 percent compliance with best management practices rules since 1996 and documents that best management practices are effective when properly installed (Stone & Hess, 2016).

Idaho Stream Channel Protection Act

The Idaho Stream Channel Protection Act requires that the stream channels of the state and their environment be protected against alteration for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty, and water quality. The Stream Channel Protection Act requires a stream channel alteration permit from Idaho Department of Water Resources before any work that would alter the stream channel may begin.

The 2018 Memorandum of Agreement and Understanding between the Forest Service and the Idaho Department of Water Resources allows certain projects to proceed without a permit if they meet the Department's Minimum Standards and the Forest Service sends out advance notification.[56] The proposed installation or replacement of stream crossing culverts would meet or exceed the Minimum Requirements under the Stream Channel Protection Act and comply with the Act.

Literature Cited

Archer, E., & Ojala, J. V. (2016). *Special report of stream habitat condition for sites in the Nez Perce-Clearwater National Forest*. Retrieved from Logan, UT:

Arismendi, I., Groom, J. D., Reiter, M., Johnson, S. L., Dent, L., Meleason, M., . . . Skaugset, A. E. (2017). Suspended sediment and turbidity after road construction/improvement and forest harvest in streams of the Trask River Watershed Study, Oregon. *Water Resources Research, 53*(8), 6763-6783. doi:10.1002/2016wr020198

Belt, G. H., O'Laugblin, J., & Merrill, T. (1992). *Design of forest riparian buffer strips for the protection of water quality: Analysis of scientific literature* (8). Retrieved from Moscow, ID:

Benda, L., & Dunne, T. (1997). Stochastic forcing of sediment supply to channel networks from landsliding and debris flow. *Water Resources Research, 33*(12), 2849-2863. doi:http://dx.doi.org/10.1029/97WR02388

Bilby, R. E., Sullivan, K., & Duncan, S. H. (1989). The generation and fate of road-surface sediment in forested watersheds in southwestern Washington. *Forest Science, 35*(2), 453-468.

Biswell, H. H., & Schultz, A. M. (1957). Surface runoff and erosion as related to prescribed burning. *Journal of Forestry, 55*(5), 372-374. doi:10.1093/jof/55.5.372

Callahan, C. P. (1996). *Water Yield Recovery in the Northern Rockies.* (Master's thesis). University of Montana, Missoula, MT.

Cooper, C. F. (1961). Controlled burning and watershed condition in the White Mountains of Arizona. *Journal of Forestry, 59*(6), 438-442. doi:10.1093/jof/59.6.438

Cristan, R., Aust, W. M., Bolding, M. C., Barrett, S. M., & Munsell, J. F. (2016). Effectiveness of forestry best management practices in the United States: Literature review. *Forest Ecology and Management, 360*, 133-151.

Cristan, R., Michael Aust, W., Chad Bolding, M., Barrett, S. M., & Munsell, J. F. (2018). National status of state developed and implemented forestry best management practices for protecting water quality in the United States. *Forest Ecology and Management, 418*, 73-84. doi:10.1016/j.foreco.2017.07.002

Dun, S., Wu, J. Q., Elliot, W. J., Robichaud, P. R., Flanagan, D. C., Frankenberger, J. R., . . . Xu, A. C. (2009). Adapting the Water Erosion Prediction Project (WEPP) model for forest applications. *Journal of Hydrology, 366*(1–4), 46-54. doi:http://dx.doi.org/10.1016/j.jhydrol.2008.12.019

Duncan, S. H., Bilby, R. E., Ward, J. W., & Heffner, J. T. (1987). Transport of road-surface sediment through ephemeral stream channels. *Water Resources Bulletin, 23*(1), 113-119. doi:10.1111/j.1752-1688.1987.tb00789.x

Dwire, K. A., & Kauffman, J. B. (2003). Fire and riparian ecosystems in landscapes of the western USA. *Forest Ecology and Management, 178*(1–2), 61-74. doi:http://dx.doi.org/10.1016/S0378-1127(03)00053-7

Edwards, P. J., Wood, F., & Quinlivan, R. L. (2016). *Effectiveness of best management practices that have application to forest roads: A literature synthesis*. (General Technical Report NRS-163). Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station

Elliot, W. J. (2004). Wepp internet interfaces for forest erosion prediction. *Journal of The American Water Resources Association, 40*(2), 299-309.

Elliot, W. J. (2013). Erosion processes and prediction with WEPP technology in forests in the northwestern U.S. *Transactions of the American Society of Agricultural and Biological Engineers, 56*(2), 563-579.

Elliot, W. J., Foltz, R. B., & Luce, C. H. (1995). Validation of water erosion prediction project (WEPP) model for low-volume forest roads. In *Conference proceedings 6: Sixth international conference on low-volume roads, vol. 1; Minneapolis, MN; June 25-29, 1995* (pp. 178-186). Washington, DC: National Academy Press.

Elliot, W. J., Hall, D. E., & Scheele, D. L. (1999). *WEPP: Road (draft 12/1999) WEPP interface for predicting forest road runoff, erosion and sediment delivery: Technical documentation, draft version*. Retrieved from Moscow, ID:

Elliot, W. J., Hall, D. E., & Scheele, D. L. (2000). Disturbed WEPP (Draft 02/2000) WEPP Interface for Disturbed Forest and Range Runoff, Erosion and Sediment Delivery. Retrieved from http://forest.moscowfsl.wsu.edu/fswepp/docs/distweppdoc.html

Elliot, W. J., Page-Dumroese, D., & Robichaud, P. R. (1999). The effects of forest management on erosion and soil productivity. In R. Lal (Ed.), *Soil Quality and Soil Erosion* (pp. 195-208). Boca Raton, FL: CRC Press.

Elliot, W. J., & Robichaud, P. R. (2001). Comparing erosion risks from forest operations to wildlife. *Proceedings of The International Mountain Logging and 11th Pacific Northwest Skyline Symposium: 2001 - A Forest Engineering Odyssey*, 78-89.

Foltz, R. B., Rhee, H., & Yanosek, K. A. (2007). Infiltration, erosion and vegetation recovery following road obliteration. *American Society of Agricultural and Biological Engineers, 50*(6), 1937-1943.

Foltz, R. B., Yanosek, K. A., & Brown, T. M. (2008). Sediment concentration and turbidity changes during culvert removals. *Journal of Environmental Management, 87*(3), 329-340. doi:http://dx.doi.org/10.1016/j.jenvman.2007.01.047

Grant, G. E., Lewis, S. L., Swanson, F. J., Cissel, J. H., & McDonnell, J. J. (2008). *Effects of forest practices on peak flows and consequent channel response: A state-of-science report for western Oregon and Washington* (General Technical Report PNW-GTR-760). Retrieved from Portland, OR: https://www.fs.fed.us/pnw/pubs/pnw_gtr760.pdf

Gucinski, H., Furniss, M. J., Ziemer, R. R., & Brookes, M. H. (2001). *Forest roads: A synthesis of scientific information* (Gen. Tech. Rep. PNW-509). Retrieved from Portland, OR: https://www.fs.fed.us/pnw/pubs/pnw_gtr509.pdf

Ice, G., Dent, L., Robben, J., Cafferata, P., Light, J., Sugden, B., & Cundy, T. (2004). Programs assessing implementation and effectiveness of state forest practice rules and BMPs in the West. *Water, Air and Soil Pollution: Focus, 4*(1), 143-169. doi:10.1023/B:WAFO.0000012821.68577.6b

Ice, G. G., Schilling, E., & Vowell, J. (2010). Trends for forestry best management practices implementation. *Journal of Forestry, 108*(6), 267-273. doi:10.1093/jof/108.6.267

Jones, J. A., & Grant, G. E. (1996). Peak flow responses to clear-cutting and roads in small and large basins, Western Cascades, Oregon. *Water Resources Research, 32*(4), 959-974. doi:http://dx.doi.org/10.1029/95wr03493

Jones, J. A., & Post, D. A. (2004). Seasonal and successional streamflow response to forest cutting and regrowth in the northwest and eastern United States. *Water Resources Research, 40*(5), 19. doi:10.1029/2003WR002952

Karwan, D. L., Gravelle, J. A., & Hubbart, J. A. (2007). Effects of timber harvest on suspended sediment loads in Mica Creek, Idaho. *Forest Science, 53*(2), 181-188.

Kirchner, J. W., Finkel, R. C., Riebe, C. S., Granger, D. E., Clayton, J. L., King, J. G., & Megahan, W. F. (2001). Mountain erosion over 10 yr, 10 k.y., and 10 m.y. time scales. *Geology, 29*(7), 591-594. doi:http://dx.doi.org/10.1130/0091-7613(2001)029<0591:meoyky>2.0.co;2

Laflen, J. M., Flanagan, D. C., & Engel, B. A. (2004). Soil erosion and sediment yield prediction accuracy using WEPP. *Journal of the American Water Resources Association, 40*(2), 289-297. doi:http://dx.doi.org/10.1111/j.1752-1688.2004.tb01029.x

Litschert, S. E., & MacDonald, L. H. (2009). Frequency and characteristics of sediment delivery pathways from forest harvest units to streams. *Forest Ecology and Management, 259*(2), 143-150. doi:http://dx.doi.org/10.1016/j.foreco.2009.09.038

Luce, C. H., & Black, T. A. (1999). Sediment production from forest roads in western Oregon. *Water Resources Research, 35*(8), 2561-2570. doi:http://dx.doi.org/10.1029/1999wr900135

Luce, C. H., & Black, T. A. (2001). Spatial and temporal patterns in erosion from forest roads. In M. S. Wignosta & S. J. Burges (Eds.), *Influence of urban and forest land uses on the hydrologic-*

geomorphic responses of watersheds (pp. 165-178). Washington, DC: Water Resources Monographs, American Geophysical Union.

Montgomery, D. R., & Buffington, J. M. (1997). Channel-reach morphology in mountain drainage basins. *GSA Bulletin, 109*(5), 596-611.

Moody, J. A., & Martin, D. A. (2009). Synthesis of sediment yields after wildland fire in different rainfall regimes in the western United States. *International Journal of Wildland Fire, 18*(1), 96-115. doi:http://dx.doi.org/10.1071/WF07162

National Soil Erosion Research Laboratory. (1995). *USDA- water erosion prediction project* (NSERL Report No. 11). Retrieved from http://soils.ecn.purdue.edu:20002/~wepp/nserl.html

Olsen, D. S., Whitaker, A. C., & Potts, D. F. (1997). Assessing stream channel stability thresholds using flow competence estimates at bankfull stage. *Journal of the American Water Resources Associaion, 33*(6), 1197-1207. doi:10.1111/j.1752-1688.1997.tb03546.x

Perry, T. D., & Jones, J. A. (2017). Summer streamflow deficits from regenerating Douglas-fir forest in the Pacific Northwest, USA. *Ecohydrology, 10*(2), 1-13. doi:10.1002/eco.1790

Rashin, E. B., Clishe, C. J., Loch, A. T., & Bell, J. M. (2006). Effectiveness of timber harvest practices for controlling sediment related water quality impacts. *Journal of The American Water Resources Association, 42*(5), 1307-1327.

Reeves, D. (2011). *Soil disturbance monitoring of timber harvest operations in the USDA Forest Service Northern Region.* (Master's thesis). University of Idaho,

Rehg, K. J., Packman, A. I., & Ren, J. (2005). Effects of suspended sediment characteristics and bed sediment transport on streambed clogging. *Hydrological Processes, 19*(2), 413-427. doi:10.1002/hyp.5540

Reiter, M., Heffner, J. T., Beech, S., Turner, T., & Bilby, R. E. (2009). Temporal and spatial turbidity patterns over 30 years in a managed forest of western Washington. *Journal of the American Water Resources Association, 45*(3), 793-808. doi:http://dx.doi.org/10.1111/j.1752-1688.2009.00323.x

Robichaud, P. R. (2000). Fire effects on infiltration rates after prescribed fire in Northern Rocky Mountain forests, USA. *Journal of Hydrology, 231-232*, 220-229.

Robichaud, P. R., & Monroe, T. M. (1997). Spatially-varied erosion modeling using WEPP for timber harvested and burned hillslopes. In *ASAE annual international meeting, Minneapolis Convention Center, Minneapolis, Minnesota, August 10-14, 1997, paper no. 97-5015* (pp. 1-9). St. Joseph, MI: American Society of Agricultural Engineers.

Roper, B. B., Saunders, W. C., & Ojala, J. V. (2019). Did changes in western federal land management policies improve salmonid habitat in streams on public lands within the Interior Columbia River Basin? *Environ Monit Assess, 191*(9), 574. doi:10.1007/s10661-019-7716-5

Safeeq, M., Grant, G. E., Lewis, S. L., & Hayes, S. K. (2020). Disentangling effects of forest harvest on long-term hydrologic and sediment dynamics, western Cascades, Oregon. *Journal of Hydrology, 580*, 124259. doi:10.1016/j.jhydrol.2019.124259

Schmalenberg, J. (n.p.). *Effects on various forest management activities on instream turbity in western Montana*. Helena, MT: Montana Department of Natural Resources Conservation

Seyedbagheri, K. A. (1996). *Idaho forestry best management practices: Compilation of research on their effectiveness* (General Technical Report INT-GTR-339). Retrieved from Ogden, UT:

State Technical Services Office, Department of Environment Quality. (2012). *Lochsa River subbasin, temperature total maximum daily loads: Addendum to the Lochsa River subbasin assessment*. Lewiston, ID: Department of Environmental Quality

Steimke, A. (2018). *Idaho's 2016 integrated report*. Boise, ID: State of Idaho Department of Environmental Quality, Water Quality Division

Stone, H., & Hess, G. (2016). *Idaho 2016 interagency forest practices water quality audit*. Retrieved from Boise:

Sugden, B. D. (2018). Estimated Sediment Reduction with Forestry Best Management Practices Implementation on a Legacy Forest Road Network in the Northern Rocky Mountains. *Forest Science, 64*(2), 214-224. doi:10.1093/forsci/fxx006

Swift, L. W., Elliott, K. J., Ottmar, R. D., & Vihnanek, R. E. (1993). Site preparation burning to improve southern Appalachian pine-hardwood stands: Fire characteristics and soil erosion, moisture, and temperature. *Canadian Journal of Forest Research, 23*(10), 2242-2254. doi:10.1139/x93-278

Switalski, T. A., Bissonette, J. A., DeLuca, T. H., Luce, C. H., & Madej, M. A. (2004). Benefits and impacts of road removal. *Frontier Ecology and the Environment, 2*(1), 21-28. doi:http://dx.doi.org/10.1890/1540-9295(2004)002[0021:Baiorr]2.0.Co;2

Traeumer, D. (2018). *Categorical exclusion worksheet: Water resources, Crane Point project-North Fork Ranger District Nez-Perce-Clearwater National Forests*. Orofino, ID: U.S. Department of Agriculture, Forest Service

Tysdal, L. M., Elliot, W. J., Luce, C. H., & Black, T. A. (1999). Modeling erosion from insloping low-volume roads with WEPP watershed model. In *Transportation research record: Seventh international conference on low-volume roads 1999* (Vol. 2, pp. 7). Washington, DC: National Academy Press.

U.S. Department of Agriculture, Forest Service. (2013). *Final environmental impact statement for the revised land management plan: Idaho Panhandle National Forests*. Missoula, MT: U.S. Department of Agriculture, Forest Service

U.S. Department of Agriculture, F. S. (1987). *Forest plan: Clearwater National Forest*. Orofino, ID: U.S. Department of Agriculture, Forest Service, Northern Region

Warrington, B., Aust, W., Barrett, S., Ford, W., Dolloff, C., Schilling, E., . . . Bolding, M. (2017). Forestry best management practices relationships with aquatic and riparian fauna: A review. *Forests, 8*(9), 331-347. doi:10.3390/f8090331

Wemple, B. C., Jones, J. A., & Grant, G. E. (1996). Channel network extension by logging roads in two basins, western Cascades, Oregon. *Water Resources Bulletin, 32*(6).

Appendix A – List of Best Management Practices

Table A-1. List of Best Management Practices (from Soil and Water Conservation Handbook with cross-references to Idaho Forest Practices Rules and Forest Service Timber Sale Contract Standard Provisions).

Category	Number	Description	Implementation
11 Watershed Management	11.01	Determination of Cumulative Watershed Effects	Potential cumulative effects of the Proposed Action to water resources are analyzed in the Water Resources Analysis (Project File E5.H36, pp. 20-21).
	11.04	Floodplain Analysis and Evaluation	My review found that the Proposed Action would not occur in floodplains (Project File E5.H36, p. 1).
	11.05	Wetlands Analysis and Evaluation	My review found that the Proposed Action would not alter wetlands (Project File E5.H36, p. 1).
	11.06	Public Supply Watershed Management	My review found that the Proposed Action would not affect public supply watersheds (Project File E5.H36, p. 1).
	11.07	Oil and Hazardous Substance Spill Contingency Planning	This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.341 and B6.342 and would meet or exceed Idaho Forest Practices Rule 060.02.
13 Vegetation Manipulation	13.02	Slope Limitations for Tractor Operations	Slope limitations would meet or exceed Idaho Forest Practices Rule 030.03.
	13.03	Tractor Operations Excluded from Wetlands, Bogs, and Wet Meadows	Wetlands, bogs, and wet meadows would be placed within Riparian Habitat Conservation Areas and protected by Timber Sale Contract Standard Provisions B6.61 and B6.62 and would meet or exceed Idaho Forest Practices Rule 030.08c.
	13.04	Revegetation of Surface Disturbed Areas	During road and landing work, disturbed areas would be seeded, where necessary, to prevent or minimize sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.6 based on field conditions and would meet or exceed Idaho Forest Practices Rules 030.04c and 030.05.
	13.06	Soil Moisture Limitations for Tractor Operations	Equipment would be prohibited from operating when excessive damage (for example, compaction, rutting, or gullying) would occur because of ground conditions. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.6 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.03a.
14 Timber	14.01	Timber Sale Planning	The potential effects of the Proposed Action to water resources are analyzed in the Water Resources Analysis (Project File E5.H36, pp. 16-21).
	14.02	Timber Harvest Unit Design	The potential effects of timber harvest unit design are analyzed in the Water Resources Analysis (Project File E5.H36, pp. 18-19).

	14.03	Use of Sale Area Maps for Designating Soil and Water Protection Needs	This Best Management Practice would be implemented through maps in the Timber Sale Contract.
	14.04	Limiting the Operating Period of Timber Sale Activities	Purchasers would be required to submit a Plan of Operation and Operation Schedule detailing planned periods of road construction, timber harvest, erosion control work, etc. for approval by the Forest Service. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.3, B6.31, B6.311, B6.312, and C6.
	14.05	Protection of Unstable Areas	Unstable areas would be identified in the field by staff with appropriate experience and placed within Riparian Habitat Conservation Areas.
	14.06	Riparian Area Designation	Riparian Areas would be identified in the field by staff with appropriate experience and placed within Riparian Habitat Conservation Areas.
	14.07	Determining Tractor Loggable Ground	Areas of ground-based operations were delineated using remotely sensed data and are identified on maps in the project record. Slight changes are anticipated during project implementation based on field conditions.
	14.08	Tractor Skidding Design	Skidding patterns would be designed to best fit the terrain and minimize runoff, erosion, and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.422 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.03c.
	14.09	Suspended Log Yarding in Timber Harvesting	Areas of suspended yarding were delineated using remotely sensed data and are identified on maps in the project record. Slight changes are anticipated during project implementation based on field conditions.
	14.10	Log Landing Location and Design	Landings would be located and designed to minimize disturbed area, erosion, and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.422 and B6.6 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.04.
	14.11	Log Landing Erosion Prevention and Control	Proper drainage would be maintained, and erosion control work would be applied, where necessary, to minimize sediment delivery to streams from landings. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.6 and B6.64 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.05.
	14.12	Erosion Prevention and Control Measures During Timber Sale Operations	Equipment would be prohibited from operating when excessive damage (for example, compaction, rutting, or gullying) would occur because of ground conditions. Erosion control would be applied, where necessary, to minimize runoff, erosion, and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.6 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.05.

	14.14	Revegetation of Areas Disturbed by Harvest Activities	After timber harvest, disturbed areas would be seeded, where necessary, to prevent or minimize sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.6 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.05.
	14.15	Erosion Control on Skid Trails	Erosion control measures such as cross ditches would be installed on skid trails, tractors roads, and temporary roads, where necessary, to minimize runoff, erosion, and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.422, B6.6, and B6.65 based on field conditions and would meet or exceed Idaho Forest Practices Rule 030.05.
	14.17	Stream Channel Protection	Stream channels would be protected by requiring that all project debris be removed from streams; limiting equipment use within Riparian Habitat Conservation Areas except as necessary for road-related activities; using water bars or other erosion control measures to prevent runoff, erosion, and sediment delivery to streams; and fully suspending logs when crossing streams where practicable. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.5 and B6.6 and would meet or exceed Idaho Forest Practices Rule 030.06 and 030.07.
	14.18	Erosion Control Structure Maintenance	Erosion control structures (for example, water bars, sediment catch basins, etc.) would be maintained in stable condition. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.6 and B6.67.
	14.19	Acceptance of Timber Sale Erosion Control Measures Before Sale Closure	Planned erosion control work would be complete and meet the prescribed standards before sale closure. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.6, B6.63, B6.64, and B6.65.
	14.22	Modification of the Timber Sale Contract	The Timber Sale Contract could be modified based on new concerns about the effects of the sale on soil and water resources, if these concerns cannot be adequately addressed within the existing contract. This Best Management Practice would be initiated by the Forest Service Representative through Timber Sale Contract Standard Provisions B8.3 and 8.33.
15 Roads and Trails	15.02	General Guidelines for the Location and Design of Roads and Trails	Temporary roads would be located outside of Riparian Habitat Conservation Areas as shown on maps in the project record. Road drainage would be designed to minimize runoff, erosion, and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.63 and would meet or exceed Idaho Forest Practices Rule 040.02.
	15.03	Road and Trail Erosion Control Plan	Purchasers would submit and implement an erosion control plan that may incorporate measures to reestablish vegetation on exposed soils, measures to control sediment movement (for example, straw bales or catch basins), measures to reduce sediment delivery in or near streams (for example, dewatering streams during culvert installation), and measures to control runoff (for example, outsloping roads). This Best Management Practice would be implemented by the Sale Administrator through Timber Sale

			Contract Standard Provisions B6.311, B6.5, and B6.6 and would meet or exceed Idaho Forest Practices Rules 040.02c and d.
	15.04	Timing of Construction Activities	Operations would be scheduled during periods when the probabilities for rain and runoff are low to prevent erosion and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.31, B6.311, and B6.6 and would meet or exceed Idaho Forest Practices Rule 040.03h.
	15.06	Mitigation of Surface Erosion and Stabilization of Slopes	Where reconstructed road segments are likely to deliver sediment to streams (for example, at stream crossings or where roads closely parallel streams), measures would be taken to stabilize disturbed surfaces and may include seeding, mulching, straw bale dams, erosion netting, etc. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.6 and B6.63 based on field conditions and would meet or exceed Idaho Forest Practices Rules 040.03c, g, and i.
	15.07	Control of Permanent Road Drainage	Where system roads are likely to deliver sediment to streams because of poor drainage, runoff would be minimized and runoff velocities dissipated by stabilizing the road prism and/or constructing control structures to minimize sediment delivery to streams (for example, properly spaced ditch relief culverts, water bars, rolling dips, armoring of ditches, insloping, outsloping, etc.). Modification needs would be developed in the field by staff with an appropriate combination of engineering/water resources per soils experience. Implementation would meet or exceed Idaho Forest Practices Rules 040.02c and d and 040.04c.
	15.09	Timely Erosion Control Measures on Incomplete Roads and Streamcrossing Projects	Before the end of the normal operating season, erosion control measures (for example, cross drains, catch basins, seeding, mulching, etc.) would be applied to areas of ground disturbance that are likely to deliver sediment to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.66 based on field conditions and would meet or exceed Idaho Forest Practices Rules 040.02c and d and 040.03c and g.
	15.10	Control of Road Construction Excavation and Sidecast Material	Material from road maintenance and reconstruction activities (for example, culvert replacement, ditch cleaning and grading, etc.) would not be sidecast onto unstable slopes or in riparian areas where it could enter streams. Instead, it would be endhauled to a stable site or otherwise properly disposed of. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.5 based on field conditions and would meet or exceed Idaho Forest Practices Rules 030.06c, 040.02b, and 040.04a.
	15.11	Servicing and Refueling of Equipment	Servicing and refueling areas for logging and construction equipment would be designated and maintained to prevent pollution to water resources. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provisions B6.34, B6.341, and B6.342 based on field conditions and would meet or exceed Idaho Forest Practice Rule 060.02.
	15.12	Control of Construction in Riparian Areas	No new road construction would occur within Riparian Habitat Conservation Areas under the Proposed Action. Construction activities would be limited to reconstruction of existing stream crossings.

	15.13	Controlling In-Channel Excavation	Construction equipment would only be permitted to cross, operate in, or operate near streams as necessary to install stream crossing culverts. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.5 and would meet or exceed Idaho Forest Practices Rules 030.07c and 040.03.
	15.16	Bridge and Culvert Installation	Turbidity and sedimentation would be minimized during culvert installation and replacement activities by using preventive measures that could include diverting stream flow around construction sites, not depositing easily erodible material in streams, using straw bale check dams in the stream channel to trap sediment from construction activities, etc. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.5 and would meet or exceed Idaho Forest Practices Rule 040.03.
	15.17	Regulation of Borrow Pits, Gravel Sources, and Quarries	The Proposed Action would use gravel from commercial sources or from the existing Jungle Point quarry. Drainage controls would be implemented at the Jungle Point quarry to prevent sediment delivery to streams and would meet or exceed Idaho Forest Practices Rule 040.03f.
	15.18	Disposal of Right-of-Way and Roadside Debris	Slash generated by road-related activities would be kept out of streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B6.5 and would meet or exceed Idaho Forest Practices Rule 040.03b.
	15.19	Streambank Protection	When necessary to prevent the erosion of stream banks after stream crossing culvert installation or replacement, armoring would be incorporated into the structure design. Structure design would be done by staff with appropriate engineering experience based on field conditions.
	15.21	Maintenance of Roads	Road maintenance may be required prior to, during, and after each period of use depending on road condition and level of use. Road maintenance activities would ensure that road drainage is adequately maintained and sediment delivery to streams is minimized. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B5.3 based on field conditions and would meet or exceed Idaho Forest Practices Rule 040.04.
	15.22	Road Surface Treatment to Prevent Loss of Materials	System roads with an aggregate surface would have enough aggregate to support haul and prevent excessive erosion and sediment delivery to streams as determined by staff with appropriate experience.
	15.23	Traffic Control During Wet Periods	Hauling would be suspended during wet weather when conditions are likely to cause excessive rutting of the road surface and sediment delivery to streams. This Best Management Practice would be implemented by the Sale Administrator through Timber Sale Contract Standard Provision B5.12 based on field conditions and would meet or exceed Idaho Forest Practices Rule 040.03h and 040.04c.
	15.24	Snow Removal Controls	When snow removal is necessary for winter operations, it would be done in a way that protects roads and adjacent resources. Cutslopes would not be undercut, and surfacing would not be bladed off the roadway. Ditches and culverts would be kept functional. Snow berms would not concentrate runoff on

			the road surface or erosive slopes. Implementation would meet or exceed Idaho Forest Practices Rules 040.04c and 040.05.
	15.25	Obliteration of Temporary Roads	Temporary roads would be recontoured or obliterated as a part of the Proposed Action. Implementation would meet or exceed Idaho Forest Practices Rule 040.04g.
18 Fuels Management	18.02	Formulation of Fire Prescriptions	Design Features in the Environmental Assessment require fire prescriptions in Riparian Habitat Conservation Areas to contribute to the attainment of Riparian Management Objectives. Implementation would meet or exceed Idaho Forest Practices Rule 030.07f.
	18.03	Protection of Soil and Water from Prescribed Burning Effects	Mitigation Measures in the Environmental Assessment prohibit the ignition of prescribed fire in Riparian Habitat Conservation Areas. Design Features require no more than 5 percent mortality in the mature forest canopy and 5 percent of areas burned at high severity within Riparian Habitat Conservation Areas. Implementation would meet or exceed Idaho Forest Practices Rule 030.07f.

[1] Project File F1, Pete King Wildlife Habitat Restoration Project Environmental Assessment.
[2] Project File F2, Design Features Pick List
[3] Project File F3, Mitigation Measures Pick List
[4] Project File E5.H35, Map of Source Water Areas near Project Activities
[5] Project File E5.H38, "Hydrologic Effects of Forest Removal and Potential Impacts on Stream Channels" by C.N. Kendall, USDA
[6] The data sources used in this analysis contained the most accurate and current information available at the time of analysis. Any changes occurring after the last update/date of retrieval will be small and inconsequential to the results of the analysis.
[7] Accessed at https://www.idahogeology.org/product/m-9
[8] Accessed at https://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/rc/rockclim.pl
[9] Project File E5.H20, Climate Parameters for Pete King
[10] Accessed at https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
[11] Project File E5.H19, Custom Soil Resource Report for Clearwater National Forest, Idaho; and Kooskia Area, Idaho County, Idaho
[12] Accessed at https://forest.moscowfsl.wsu.edu/fswepp/batch/dWb.html
[13] Project File E5.H29, USFS Disturbed WEPP Batch Modeling Results – Existing Condition
[14] Project File E5.H30, USFS Disturbed WEPP Batch Modeling Results – Post-Treatment Condition
[15] Project File E5.H17, GRAIP_Lite Technical Guide
[16] Project Files E5.H28, WEPP:Road Survey Forms; and E5.H27, Collector for ArcGIS Field Notes
[17] Accessed at https://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/wr/wepproadbat.pl
[18] Project File E5.H32, WEPP: Road Batch Modeling Results
[19] This provides an overestimate of open acres. Although this analysis assumes that all previous timber harvest used clearcutting, in reality there was a combination of single tree selection, commercial thinning, salvage logging, and regeneration harvest with various levels of retention.
[20] Project File E5.H34, Map of Project Activities and Subwatersheds
[21] Road-related activities within 300 feet of streams only.
[22] Project File E5.H26, Idaho Administrative Code 58.01.02
[23] Project Files E5.H9, IDEQ 2016 §305(b) Status Report: Lochsa River – Deadman Creek to Mouth; E5H10, IDEQ 2016 §305(b) Status Report: Pete King Creek – source to Walde Creek; E5.H11, IDEQ 2016 §305(b) Status Report: Pete King Creek – Walde Creek to mouth; E5.H12, IDEQ 2016 §305(b) Status Report: Pete King Creek – Walde Creek to mouth; and E5.H13, IDEQ 2016 §305(b) Status Report: Walde Creek – source to mouth
[24] Project File E1.4, Supplemental Environmental Impact Statement – North Lochsa Face Ecosystem Management Project, p. 3-221
[25] Project Files E1.4, Supplemental Environmental Impact Statement – North Lochsa Face Ecosystem Management Project, p. 3-222; E5.8, 2015 Cobble Embeddedness Spreadsheet; E5.H16, 2019 Cobble Embeddedness Spreadsheet
[26] Project File E5.H16, 2019 Cobble Embeddedness Spreadsheet
[27] Project File E5.H5, Watershed Condition on the Clearwater National Forest, p. 38
[28] Project File E5.H7, Long-term Percent Fines in Steelhead Spawning Habitat Monitoring Results
[29] Project File E5.H11, IDEQ 2016 §305(b) Status Report: Pete King Creek – Walde Creek to mouth
[30] Project File E1.4, Supplemental Environmental Impact Statement – North Lochsa Face Ecosystem Management Project, p. 3-223
[31] Data from the Forest Service Activity Tracking System (FACTS) database; retrieved on 10/10/2019. Due to overlap in the areas affected by different types of harvest (for example, multiple entry regeneration harvest), some of these acres are counted twice. Table 6 shows the total acres harvested in the subwatershed.
[32] Data from the Forest Service Infrastructure (Infra) database; retrieved on 10/10/2019.
[33] Key reach is near mouth unless otherwise specified.
[34] From the Clearwater Forest Plan (USDA Forest Service, 1987, Appendix K)
[35] Data from the Forest Service Activity Tracking System (FACTS) database; retrieved on 10/10/2019.
[36] Data from the Forest Service R1 Fire Occurrence and R1 Fire Perimeter GIS point layers; retrieved on 10/18/2019.
[37] Project File E5.H31, Peak Stream Flow Modeling Spreadsheet
[38] Project File E5.H18, PIBO Monitoring Results Spreadsheet. The PACFISH INFISH Biological Opinion Monitoring Program (PIBO) provides quality-controlled stream habitat monitoring data to users. This research has not been formally reviewed by PIBO and the views expressed here are solely those of the authors. PIBO does not endorse any products or commercial services mentioned in this publication.
[39] Project File E5.H22, Relative Bed Stability Modeling Spreadsheet

[40] Project File E5.H23, Relative Bed Stability Methods and Interpretation
[41] Project File E5.H4, The Wilderness Society v. F. Dale Robertson – Stipulation of Dismissal
[42] Project File E5.H26, Idaho Administrative Code 58.01.02 §051
[43] Project File E5.H15, Idaho Forest Practices Act Guidance
[44] Project File E5.H3, Forest Service Handbook 2509.22
[45] Accessed at https://streamstats.usgs.gov/ss/
[46] Project File E5.H37, "Fuel Management and Water Yield" by C. Troendle, L.H. MacDonald, C.H. Luce, & I.J. Larsen in Cumulative Watershed Effects of Fuel Management in the Western United States (2010).
[47] Accessed at https://apps.fs.usda.gov/wcatt/
[48] Riparian Habitat Conservation Areas would have no timber harvest within 100 – 300 feet of streams. Compare this to Stream Protection Zones on non-Forest Service lands that limit – but do not prohibit – timber harvest within 30 – 75 feet of streams.
[49] Indicated by a forest cover condition rating of "good" in the Watershed Condition Class and Prioritization Information database. Accessed at https://apps.fs.usda.gov/wcatt/.
[50] Project File E5.H33, Map of Low-Gradient Stream Reaches
[51] Project File E5.F18, Stream Survey Documentation
[52] Project File E5.H26, Idaho Administrative Code 58.01.02 §250.01e
[53] Project File E5.H1, Executive Order 11988 – Floodplain Management
[54] Project File E5.H2, Executive Order 11990 – Protection of Wetlands
[55] Project File E5.H6, Memorandum of Understanding between the Idaho Department of Environmental Quality, Idaho Department of Lands, Bureau of Land Management, and U.S. Forest Service
[56] Project File E5.H14, Memorandum of Agreement between the Idaho Department of Water Resources and U.S. Forest Service

Some parts of this document may not be readable by computer-assisted reading devices. If you need assistance with this document, please contact: Chandra Neils, North Idaho Strike Team Leader, chandra.neils@usda.gov, 208-765-7248